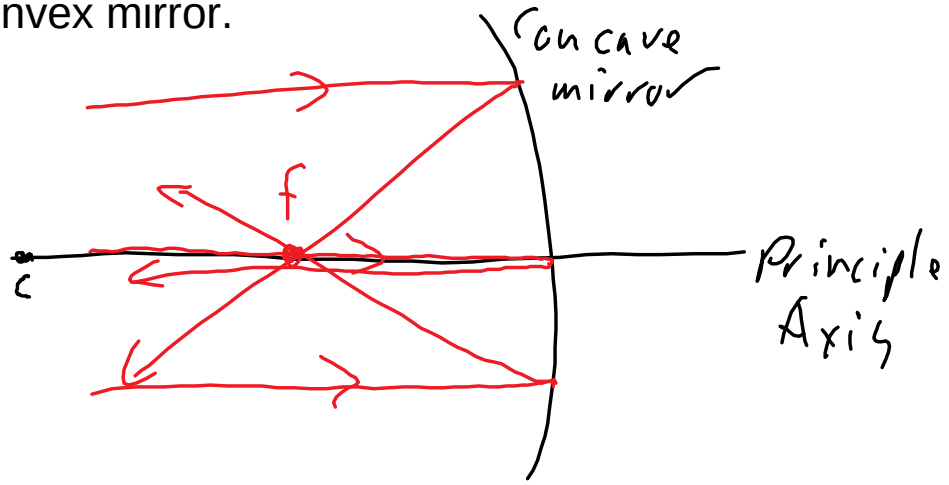
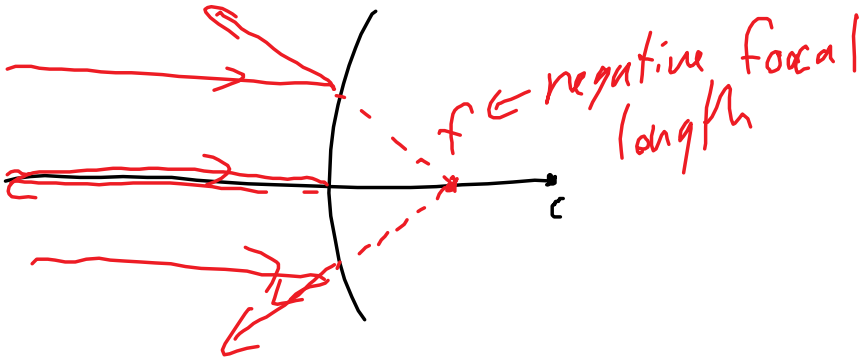
Curved Mirrors
Concave Mirror - The image is:
close the image is upright and enlarged
far, the image is upside down
- can focus light to a point.

Convex Mirror - The image is upright and smaller.
- light spreads out

focal point - parallel beams of light converge for a concave mirror and spread away from for a convex mirror.



rays parallel to the principle axis (through the centre of the mirror) reflect to the focal point.



Parallel light rays come from and object very far away, creating an image at the focal point.

The focal length, f is about half of the radius of the spherical mirror, f=1/2 c

If an object is closer, we can determine the

location of the image using
1. a scale ray diagram
2. the lens maker's equation
$1/f = 1/d_o + 1/d_i$ and $m=h_i/h_o = -d_i/d_o$

f is focal length, negative for diverging mirrors/lenses (convex mirror)

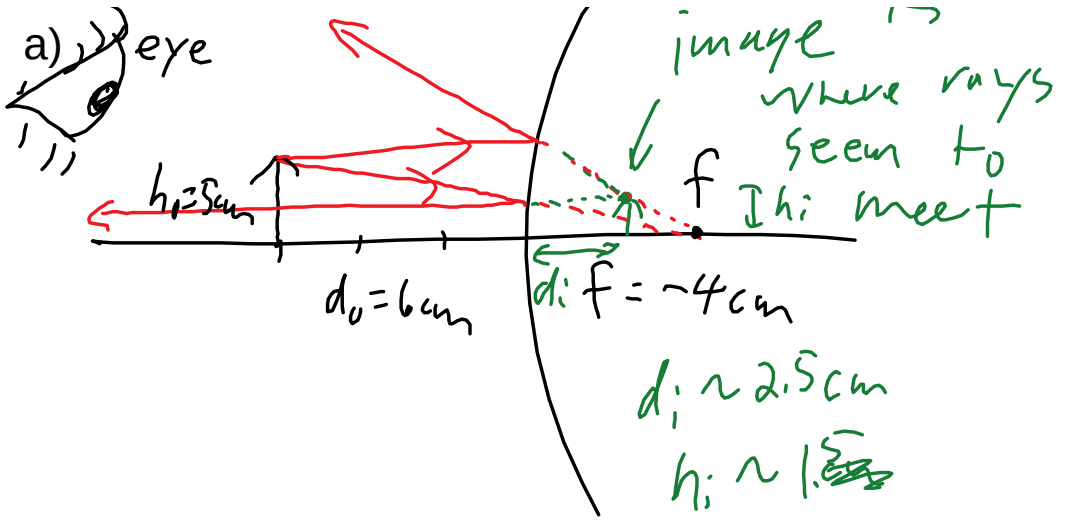
d_o is distance from the mirror to the object
d_i is the distance from the mirror to the image
m is magnification, no units or X - if you have a magnification of 2X , the image is twice the size of the object.

h_i is the size of the image
h_o is the size of the object

eg. A 5.0 cm object is 6.0 cm from a mirror.
What is the size, location and type of image if
a) convex mirror focal length -4.0cm
b) concave mirror focal length 4.0 cm
c) concave mirror focal length 8.0 cm

answer using lensmaker's equation and a scale ray diagram.

ray diagram steps:
1. principle axis - line centre of the mirror/lens
2. draw the mirror or lens
3. mark the focal point(s)
4. draw the object as an arrow above the principle axis.
5. draw rays from the top of the object
   - rays parallel to the principle axis go through or from the focal point
   - rays to/from the focal point go parallel to the principle axis
   - lenses - draw a ray through the centre and it goes straight through.



$d_i \approx 2.5cm$

$h_i \approx 1.5$

$m \approx 0.3$

Virtual image - not formed by rays converging

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{-4cm} = \frac{1}{6cm} + \frac{1}{d_i} \rightarrow \frac{3}{-12} = \frac{2}{12cm} + \frac{1}{d_i}$$

$$-\frac{5}{12} = \frac{1}{d_i}$$

$$d_i = -\frac{12}{5} = \boxed{-2.4cm}$$

$$m = \frac{-d_i}{d_o} = \frac{-(-2.4cm)}{6.0cm} = \boxed{0.40\times}.$$

$$h_i = m h_o = 0.40 \times 5cm$$

$$= \boxed{2.0cm}$$

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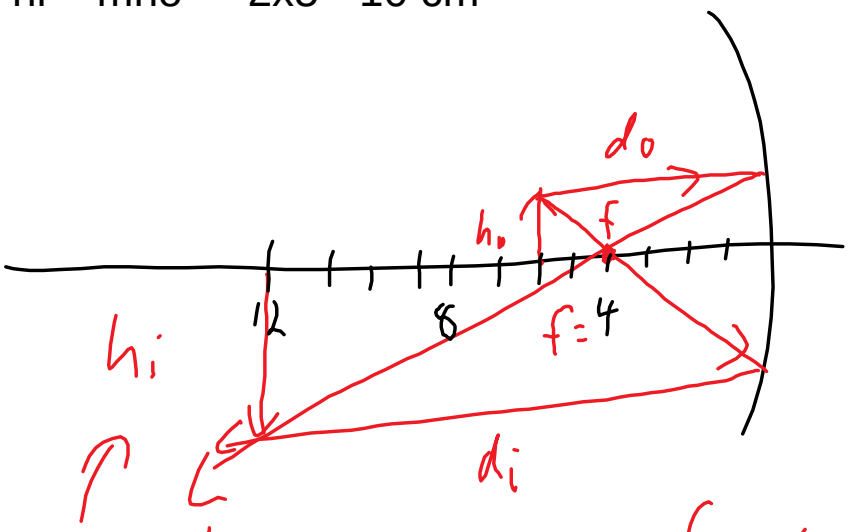
students who missed pinhole, go do it.

b) concave mirror, focal length 4.0 cm

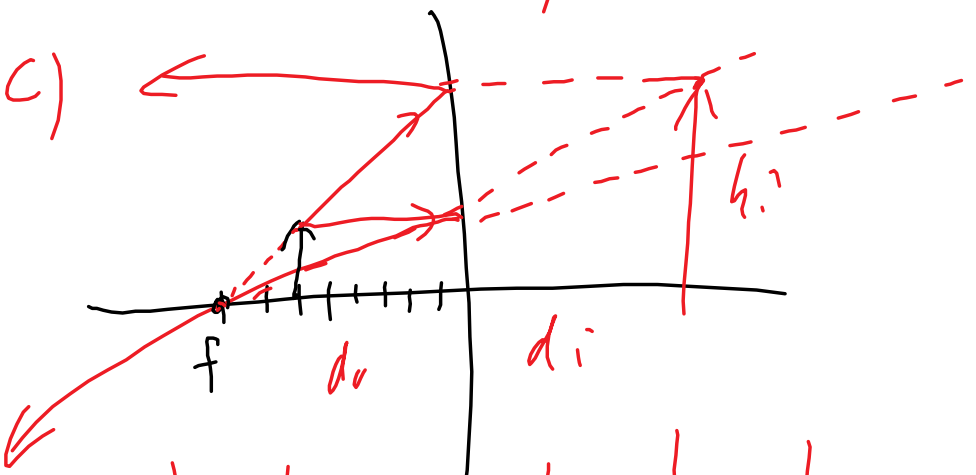
1/f = 1/do + 1/di
1/4cm = 1/6cm + 1/di
3/12cm = 2/12cm + 1/di
1/12cm = 1/di
di=12cm

m=-di/do = =-12/6 = -2X
hi = mho = -2x5=-10 cm



real image - rays focus together

c)



$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ $\frac{1}{8} = \frac{1}{6} + \frac{1}{d_i}$

$\frac{3}{24} = \frac{4}{24} + \frac{1}{d_i}$

$\frac{-1}{24} = \frac{1}{d_i}$

$d_i = -24\text{cm}$

$d_i = -24\,cm$

$m = \frac{-d_i}{d_o} = \frac{-(-24)}{6} = 4\times$

$h_i = 4 \times 5 = 20\,cm$

if you are not careful about drawing straight lines, your ray diagram will be off the equation.
- the equation is based on negligible curvature of the mirror - so reality will be a bit off.

eg. A 3.0 cm object is 6.0 cm from a mirror.
What is the size, location and type of image if
a) convex mirror focal length -4.0cm
b) concave mirror focal length 4.0 cm
c) concave mirror focal length 8.0 cm

answer using lensmaker's equation and a scale ray diagram.

ray diagram steps:
1. principle axis - line centre of the mirror/lens
2. draw the mirror or lens
3. mark the focal point(s)
4. draw the object as an arrow above the principle axis.
5. draw rays from the top of the object
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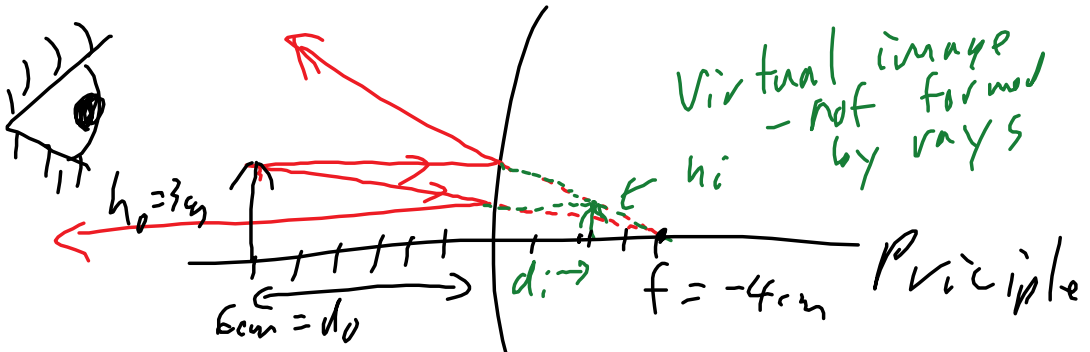
2 - rays to/from the focal point go parallel to the principle axis
- lenses - draw a ray through the centre and it goes straight through.

a)



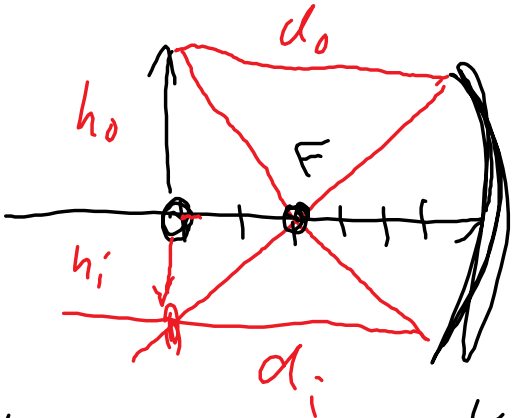
$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad = \quad \frac{1}{-4cm} = \frac{1}{6cm} + \frac{1}{d_i}$$

$$\frac{3}{-12cm} = \frac{2}{12cm} + \frac{1}{d_i}$$

$$-\frac{5}{12cm} = \frac{1}{d_i}$$

$$d_i = -\frac{12cm}{5} = \boxed{-2.4cm}$$

b)



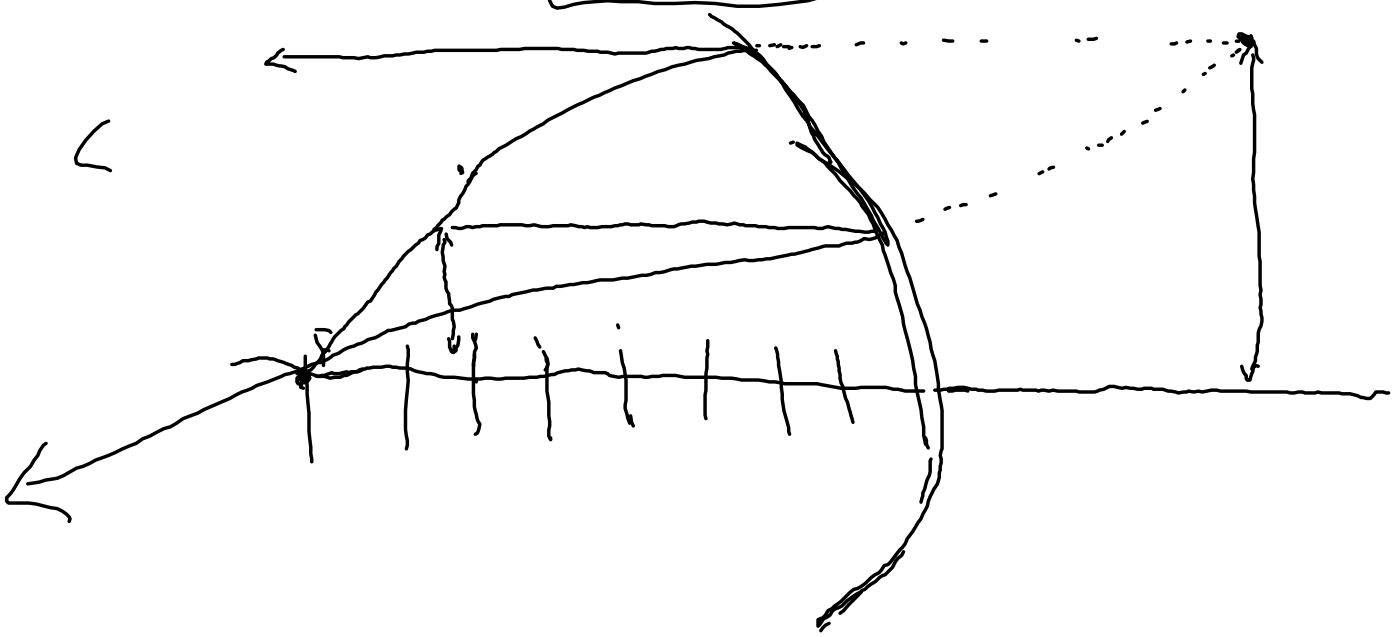
inverted and real ← formed by rays

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{4} = \frac{1}{6} + \frac{1}{d_i} = \frac{3}{12} = \frac{2}{12} + \frac{1}{d_i}$$

$$\boxed{d_i = 12cm}$$

$d_i = 12$ cms



$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{8} = \frac{1}{6} + \frac{1}{d_i}$$

$$\frac{3}{24} = \frac{4}{24} + \frac{1}{d_i}$$

$$-\frac{1}{24} = \frac{1}{d_i}$$

$d_i = -24$ cms